

DECEMBER,2024

Atomic Structure, Periodicity of elements and Chemical Bonding

Full Marks: 100

Time: 3 hrs

ANSWER ALL THE GROUPS

Figures in the right hand margin indicate marks

PART- I

1. **Answer the following: -** **(1× 10)**
- a. The designation of an orbital with $n = 4$ and $l = 2$ is :
- i) 4s ii) 4p iii) 4d iv) 4f
- b. The ion which is iso-electronic with CO is :-
- i) CN^- ii) O_2^- iii) N_2^+ iv) O_2^+
- c. Filling of 4S sub- shell begins in atomic number :-
- i) 19 ii) 21 iii) 31 iv) 41
- d. What is the shape of a d- Orbital ?
- i) Spherical ii) Dumbbell iii) Double Dumbbell iv) Circular
- e. The ion having largest size is :
- i) F^- ii) N^{3-} iii) Al^{3+} iv) Mg^{2+}
- f. The element having highest value of 1st ionization energy is :
- i) B ii) C iii) N iv) O
- g. What is the shape of ClF_3 molecule ?
- h. Which of the following molecules, which has the strongest hydrogen bonding?
- i) CH_4 ii) NH_3 iii) HCl iv) CO_2
- i. A Species which is formed by co-ordinate covalency is : ?
- i) NH_4^+ ii) BF_3 iii) NH_3 iv) PCl_5
- j. The bond order of O_2 molecule is _____ .

PART- II

2. **Answer all the questions -** **(2× 9)**
- a. Which among the following is more stable electronic configuration and Why?
- i) $4S^2 3d^9$ ii) $4S^1 3d^{10}$
- b. Draw the shapes of $d_{x^2-y^2}$ and d_{z^2} orbitals.
- c. What is ionization potential? How does it vary in a period and group?
- d. NH_3 molecule has pyramidal shape – Explain.
- e. On the basis of M.O. theory explain- Oxygen molecule is paramagnetic.
- f. He_2 does not exist-Explain.
- g. Write Born-Landé equation and define the terms involved in it.
- h. Define intermolecular hydrogen bonding by giving an example. .
- i. Why metals are good conductors of heat and electricity?

PART- III

3. Answer any Eight of the following questions - (5× 8)
- a. Write a note on Heisenberg's uncertainty principle.
 - b. State and explain Pauli's Exclusion Principle with examples. (2+3)
 - c. Write a note on Aufbau principle.
 - d. Explain electronegativity and its variation in the periodic table. (3+2)
 - e. Write a note on atomic radius.
 - f. What is salivation energy? Discuss the factors affecting salivation energy. (2+3)
 - g. Describe Pauling's scale and Mulliken's scale of electro negativity. (2 $\frac{1}{2}$ + 2 $\frac{1}{2}$)
 - h. Why does water (H₂O) have a bent shape, whereas methane (CH₄) has a tetrahedral shape? (2 $\frac{1}{2}$ + 2 $\frac{1}{2}$)
 - i. What are semiconductors and insulators based on the band model?
 - j. What is hydrogen bonding and how does it affect the properties of water? (2+3)

PART-IV

4. Answer any Four of the following questions: [8×4]
- a. Derive Schrodinger's wave equation for Hydrogen atom. What are the significances of wave function φ [6+2]
 - b. Write notes on: (Any two) [4+4]
 - i) Hund's rule
 - ii) Electron affinity
 - iii) Dipole moment
 - c. What is electron affinity. Discuss the various factors that affects and explain the trends in their variation along a period and down a group. [2+3+3]
 - d. What is lattice energy? Derive Born Lande equation and give its importance. [2 +4+ 2]
 - e. Write the postulates of VSEPR theory and explain the shape of following molecules on the basis of VSEPR theory.
 - i) NH₄⁺
 - ii) SF₆[3+2 $\frac{1}{2}$ +2 $\frac{1}{2}$]

DECEMBER, 2024
FUNDAMENTAL ORGANIC CHEMISTRY

Full Marks: 100

Time: 3 hrs

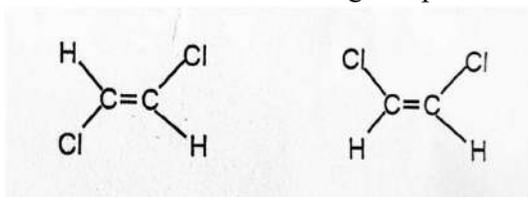
Answer all the parts
Figures in the right hand margin indicate marks

PART-I

1. **Answer all questions or fill in blanks as required.** **(1×10)**
- a. Which of the following is an electrophile:
i) OH^- ii) BF_3 iii) NH_3 iv) Cl^-
- b. The number of π – bonds in Buta-1,3-diene is _____?
- c. What is the order of stability of carbocations?
i) Tertiary > Secondary > Primary > Methyl
ii) Methyl > Primary > Secondary > Tertiary
iii) Primary > Secondary > Tertiary > Methyl
iv) Secondary > Primary > Tertiary > Methyl
- d. Between ethyl amine and aniline which is more basic ?
- e. When Sodium is treated with an equimolar mixture of CH_3Br and $\text{C}_2\text{H}_5\text{Br}$, which of the following is not formed:
i) Methane ii) ethane iii) Propane iv) Butane
- f. The shape of CH_3^+ is _____ \therefore
- g. According to Baeyer's strain theory, which of the following cycloalkane is the most stable?
i) Cyclopropane ii) Cyclobutane
iii) Cyclopentane iv) Cyclohexane
- h. The separation of a racemic mixture into its two enantiomers is known as _____ .
- i. Which of the following is an example of a non-benzenoid aromatic compound?
a) Benzene b) Cyclopropenyl cation c) Toluene d) Naphthalene
- j. In Kolbe's electrolysis of CH_3COONa , ethane is obtained at which electrode?

PART-II

2. **Answer all the questions :** **(2 ×9)**
- a. AlCl_3 is an electrophile - Justify.
- b. Define the term heterolytic fission by giving an example.
- c. Chloro acetic acid is more acidic than acetic acid - Why?.
- d. Define the term diastereomers.
- e. What are free radicals? Give an example.
- f. Eclipsed form is less stable than staggered form- Why?
- g. Assign cis and trans to the following compounds:



- h. What happens when But-2-ene undergo Ozonolysis ?
- i. Between Chair form and Boat form of Cyclo hexane, which is more stable and why?

PART-III

3. **Answer any Eight of the following questions** (5× 8)
- Write a note on - Inductive effect ?
 - Explain mesomeric effect in Aniline and Nitrobenzene. (2½ + 2½)
 - Define hyperconjugation. How does it affect the stability of carbocations? (2 + 3)
 - Differentiate between enantiomers and diastereomers with examples.
 - Explain the Markownikoff and Anti-Markownikoff rules with examples of electrophilic addition reactions of alkenes. (2½ + 2½)
 - Explain and give mechanism of Oxy-mercuration- demercuration reaction
 - Explain the Friedel-Craft's alkylation and acylation reaction with mechanism. (2½ + 2½)
 - Explain the Wurtz reaction and Corey-House reaction for the preparation of alkanes. (2½ + 2½)
 - What is the Diels-Alder reaction? Explain its mechanism and give an example of its application. (2+2+1)
 - Discuss the sulphonation of Benzene with mechanism. (2 + 3)

PART-IV

- Answer any Four of the following questions** [8×4]
4. a. What are Carbanions? Discuss the structure and relative stabilities of primary, secondary and tertiary Carbanions? [2+3+3]
- b. i) What is Optical isomerism? What are the conditions for optical isomerism? Discuss the optical isomerism of tartaric acid. [1½+1½+ 3]
- ii) What is Syn-anti isomerism? [2]
- c. Write notes on: [4+4]
- i) Ozonolysis of alkyne iii) Saytzeff's rule
- d. Complete the following: [2×4]
- $\text{CH}_3\text{-CH}=\text{CH}_2 \xrightarrow[\text{Zn/H}_2\text{O}]{\text{O}_3} ?$
 - $\text{CH}_3\text{-CH}=\text{CH}_2 + \text{HBr} \xrightarrow{\text{Peroxide}} ?$
 - $\text{CH}_3\text{-CH}_2\text{-Cl} + \text{KOH (Alc)} \rightarrow ?$
 - $\text{CH} \equiv \text{CH} + \text{H}_2\text{O} \xrightarrow{\text{H}_2\text{SO}_4/\text{HgSO}_4} ?$
- e. Define aromaticity and explain Hückel's rule. Discuss the aromatic nature of benzenoid and non-benzenoid compounds with examples. [2+2+2+2]

DECEMBER,2024
Atomic Structure, Periodicity of elements and
Chemical Bonding

Full Marks: 100

Time: 3 hrs

Answer all the parts
Figures in the right hand margin indicate marks

PART-I

1. Answer the all questions:

(1 × 10)

- a. The set of quantum numbers not applicable to an electron is :-
i) $2,0,0,+\frac{1}{2}$ ii) $1,0,0,+\frac{1}{2}$ iii) $1,0,0,-\frac{1}{2}$ iv) $1,1,1,+\frac{1}{2}$
- b. Which quantum number determines the shape of an orbital ?
- c. The preference of three unpaired electrons in the nitrogen atom can be explained by:
i) Pauli's exclusion principle ii) Aufbau's Principle
iii) Uncertainty principle iv) Hund's rule
- d. The designation of an orbital with $n = 4$ and $l = 3$ is :
i) 4s ii) 4p iii) 4d iv) 4f
- e. How many unpaired electrons are present in Cr ($Z=24$).
- f. The wave function (ψ) of an atomic orbital represents:
a) The probability of finding an electron at a point
b) The energy of an electron
c) The size of an atom
d) The spin of an electron
- g. Which of the following has the smallest size?
i) Al ii) Al^+ iii) Al^{+2} iv) Al^{+3}
- h. What type of hybridization exists in the Central atom of BCl_3 molecule?
- i. Lattice energy of an ionic compound depends upon:
i) The charge and size of ions ii) The number of electrons in the outermost shell
iii) The shape of the molecule iv) The type of hybridization
- j. The bond angle between the adjacent SP^3 hybridised orbital is –
i) 90° ii) $109^\circ 28'$ iii) 120° iv) 107°

PART-II

2. Answer all the questions:

(2 × 9)

- a. Write the values of n , l , m and s for the 4S electron.
- b. Why 4S orbital is filled earlier than a 3d-orbital ?
- c. What is the significance of ψ and ψ^2 in quantum mechanics?
- d. Write the electronic configuration of the following:
i) Cr ii) Fe^{3+}
- e. Electron affinity of F is less than that of Cl, why ?

- f. How do atomic and ionic radii change across a period and down a group?
- g. Why sigma bond is stronger than pi bond?
- h. Write the molecular electronic Configuration of N₂ and O₂.
- i. What is the radius ratio rule?

PART-III

3. Answer any Eight of the following questions : (5× 8)
- a. State and explain Hund's rule of maximum spin multiplicity with examples. [2+3]
- b. Write a note on - Heisenberg's Uncertainty Principle.
- c. Define ionization energy and describe its variation across periods and groups. [2+3]
- d. Derive Schrödinger's wave equation for the hydrogen atom.
- e. What is hybridization? Explain about the hybridization involved and shape of NH₃ molecule. [2+3]
- f. Explain about the shapes of the following species -
- i) H₂O ii) NH₄⁺ [2 $\frac{1}{2}$ + 2 $\frac{1}{2}$]
- g. Explain the magnetic nature of the following with reason :
- i) O₂ ii) N₂ [2 $\frac{1}{2}$ + 2 $\frac{1}{2}$]
- h. Describe Sommerfeld's extension of Bohr's theory.
- i. Write a note on - Fajan's rules . [5]
- j. Explain - Hydrogen bond with types by giving an example from each. [2+1 $\frac{1}{2}$ + 1 $\frac{1}{2}$]

PART-IV

4. Answer any Four of the following questions: (8× 4= 32)
- a. Explain Rutherford's nuclear model of the atom and its limitations. [6 + 2]
- b. Describe all the four Quantum numbers with their significance? [6 + 2]
- c. Discuss- electron gain enthalpy. Discuss the various factors that affects and the trends in their variation along a period and down a group. [2 +4+2]
- d. What is lattice energy ? How lattice energy of NaCl can be determined by Born-Haber Cyclic Process? [2 + 6]
- e. Draw and explain the molecular orbital diagrams of N₂ and O₂ molecules. Calculate their bond orders. [4+ 4]
